Changkat Changi Secondary School

Physics Department

Secondary 4E/5N PHYSICS Handbook

This belongs to

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CONTENT PAGE

1. S.I. units and prefixes

- **S.I.unit list :**

Physical quantity	Name of S.I. unit	Symbol for unit	Instruments
Length	metre	**m**	Vernier caliper/ micrometer
Time	second	**s**	Stopwatch
Mass	kilogram	**kg**	Beam Balance
Weight	newton	**N**	Spring Balance
Force	newton	**N**	Newton meter
Energy	joule	**J**	--
Power	watt or Joule per second	**W/ Js^{-1}**	--
Temperature	kelvin	**K**	Thermometer
Frequency	hertz	**Hz**	--
Electric current	ampere	**A**	Ammeter
Charge	coulomb	**C**	--
P.d or E.m.f.	voltage	**V**	Voltmeter
Resistance	ohm	**Ω**	--

- **Prefixes:**

Name	Prefix	Power
giga	**G**	10^{9}
mega	**M**	10^{6}
kilo	**k**	10^{3}
deci	**d**	10^{-1}
centi	**c**	10^{-2}
milli	**m**	10^{-3}
micro	**µ**	10^{-6}
nano	**n**	10^{-9}

2. Key Formulas

Unit 1: Measurements	
1. Finding period of pendulum: T = Time taken for n number of swings / n	*where* n = no. of swings in a pendulum
Unit 2: Kinematics	
2. $v = \frac{d}{t}$	where *v* = speed (ms^{-1}), *d = distance moved (m),* *t = time taken (s).*
3. average speed = $\frac{\text{total distance travelled}}{\text{total time taken}}$	
4. $a = \frac{v-u}{\Delta t}$	where *a = acceleration (ms^{-2}),* *v = final velocity (ms^{-1}),* *u = initial velocity (ms^{-1}),* *Δt = time taken (s).*
Unit 3: Forces and Pressure	
5. F = ma	where *F = resultant force (N),* *m = mass of object (kg),* *a = acceleration of object (ms^{-1}).*
6. $P = \frac{F}{A}$	where *P = Pressure ($N\ m^{-2}$ / Pa),* *F = resultant force (N),* *A = Area of contact (m^{-1}).*
Unit 4: Mass, Weight and Density	
7. *W = mg*	*where W* = weight (N), *m* = mass (kg), *g* = gravitational field strength (Nkg^{-1}).
8. $D = \frac{m}{v}$	where *D* = density, *m* = mass, *v* = volume.

Unit 5: Moments	
9. $M = F \times d$	*where* M = moment of a force (Nm), F = force (N), d = **perpendicular distance** from pivot (m).
10. Principle of Moments: Taking moments about the same pivot, Total Clockwise moments = Total anticlockwise moments	
Unit 6 : Energy, Work and Power	
11. $G.P.E. = mgh$,	*where* $G.P.E.$ = gravitational potential energy (J), m = mass (kg), g = gravitational field strength (Nkg^{-1}). h = *height (m)*
12. $K.E. = \frac{1}{2}mv^2$	*where* $K.E.$ = kinetic energy (J), m = mass of the body (kg), v = speed of the body (ms^{-1}).
13. $W = F \times s$	*where* W = work done by a constant force (J), F = constant force (N), s = distance moved by the object in the direction of the force (m).
14. $P = \frac{E}{t} = \frac{W}{t}$	*where* P = power (W), E = energy converted (J), W = work done (J), t = time taken (s).
Unit 7 : Kinetic Model of Matter – NA	
Unit 8 : Transfer of Thermal Energy -- NA	
Unit 9 : Thermal Properties of Matter -- NA	

Unit 10: Light	
15. $n = \frac{\sin i}{\sin r}$	*where n = refractive index,* *i = angle of incidence of light in air or vacuum,* *r = angle of refraction of light.*
16. $n = \frac{c}{v}$	*where n = refractive index,* *c = speed of light in air or vacuum* --3 x 10^8 m/s *v = speed of light in medium*
17. $n = \frac{1}{\sin C}$	*where n = refractive index,* *C = critical angle,*
Unit 11: Waves	
18. $f = \frac{1}{T}$ **19.** $v = f\lambda$ or $V = \frac{\lambda}{T}$	*where f = frequency (Hz),* *T = period (s).* *where v = wave speed (ms^{-1}),* *f = frequency (Hz),* *λ = wavelength (m).*
Unit 12: EM Waves -- Formulas used same as that of waves	
Unit 13: Sound	
20. *Finding speed of sound using echo method:* $S = \frac{2D}{t}$	where *D* = distance (m) or depth (m) *t* = time (s) Speed of sound is usually 340 m/s
Unit 14: Static Electricity --NA	

Unit 15: Current Electricity	
21. $I = \frac{Q}{t}$	*where I = current (A),* *Q = charge (C),* *t = time taken (s).*
22. $\varepsilon = \frac{W}{Q}$	*where ε = e.m.f. of a power supply (V),* *W = amount of electrical energy* ***converted from non – electrical forms*** *(J),* *Q = amount of charge (C).*
23. $V = \frac{W}{Q}$	*where V = potential difference (V),* *W = electrical energy* ***converted to other forms*** *(J),* *Q = amount of charges (C).*
24. $R = \frac{V}{I}$	*where R = resistance (Ω),* *V = p.d. across the component (V),* *I = current flowing through it (A).*
25. $R = \rho \frac{l}{A}$	*where R = resistance of wire (Ω),* *ρ = resistivity of wire (Ωm),* *l = length of wire (m),* *A = cross – sectional area or thickness of wire (m^2).*
Unit 16: D.C. Circuit	
26. In a series circuit, $V = V_1 + V_2 + \ldots + V_N$ **27.** In a series circuit, $R = R_1 + R_2 + \ldots + R_N$ **28.** In a parallel circuit, $I = I_1 + I_2 + \ldots + I_N$ **29.** In a parallel circuit, $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_N}$	

Unit 17: Practical Electricity	
30. $P = VI = I^2R = \frac{V^2}{R}$,	*where P = electrical power (W),* *V = potential difference or voltage (V),* *I = current (A),* *R = resistance (Ω)*
31. $E = Pt$	*where E = electrical energy (J),* *P = electrical power (W),* *t = time (s)*
32. $E = VIt$	*where E = electrical energy (J),* *V = potential difference or voltage (V),* *I = current (A),* *t = time (s)*
33. Cost of electricity = Power (kW) x Time (Hr) x cost per unit kWh	
Unit 18: Magnetism and Electromagnetism -- NA	

Conversion List:

- Unit conversion for length:
  ÷10 ÷100 ÷1000
  mm → cm → m → km
  mm ← cm ← m ← km
  x10 x100 x1000

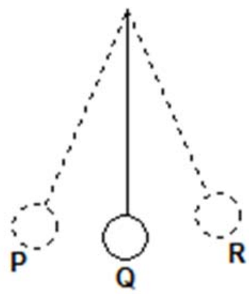
- Unit conversion for mass:
  ÷1000
  g → kg
  g ← kg
  x1000

- Unit conversion for time:
  ÷60 ÷60
  s → min → h
  s ← min ← h
  x60 x60

3. Key Definitions and concepts *(Things to remember in bold)*

Unit 1: Measurements

1. **Period, T:** The time taken for a pendulum/ object to make one complete oscillation.



One oscillation is :
P to Q to R back to P or
Q to R to P to Q etc…

2. Based on the relationship of
   Time ,T = $\sqrt{l/g}$
   where l = length of pendulum
   g = acceleration due to gravity ,

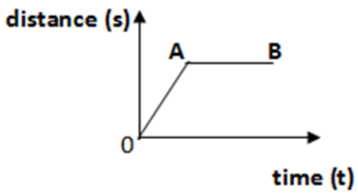
   a. with a greater length, l, it would take a longer time, T, to make one oscillation.
   b. smaller g (e.g.on Moon), greater time
   c. mass has no effect on time

Unit 2: Kinematics

3. **Difference between scalars and vectors**:
   i. Scalars are physical quantities which have magnitude only, e.g. speed, mass etc.
   ii. Vectors are physical quantities which have magnitude and direction, e.g. velocity, force, etc.

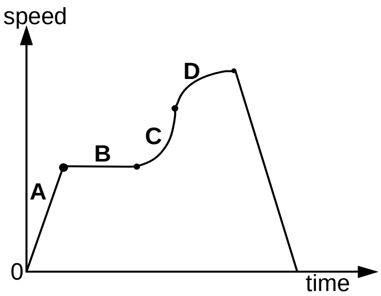
4. Acceleration of free fall, g, is defined as the acceleration of all objects falling near earth's surface. This value is 10 ms^{-2}.

Distance versus time graph



OA : constant velocity
AB : zero velocity = at rest.

Speed versus time graph



A : constant acceleration
B : Constant speed

C & D : non uniform acceleration

To find **acceleration** , calculate **gradient** of speed time graph.

To find **distance,** calculate **area under graph.**

Unit 3: Forces and pressure

5. Newton's Laws:

i. 1st Law state—An object at rest will remain at rest and an object in motion continues in a straight line motion unless acted by external force.

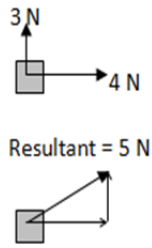
ii. 2nd Law states – Resultant force on a body is the product of the mass and acceleration of the body.

iii. 3rd Law states – For every action, there is an equal and opposite reaction.

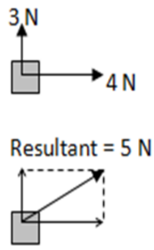
6. Pressure is force acting per unit area. Unit is N m^{-2} or Pascal (Pa).

Resolving forces

Triangle method



Parallelogram method



Note: decide scale before drawing!

Unit 4 Mass, Weight and Density

7. Mass is the measure of the amount of substance in a body. Unit is Kilogram.

8. Weight is the force of gravity acting on an object of mass, m. Unit is Newton

9. Difference between Mass and Weight:

i. Mass depends on the amount of substance in a body whereas weight depends on amount and also the gravitational force acting on it.

ii. Mass is measured using electronic beam balance whereas weight is measured using spring balance or Newton meter.

iii. Mass is a scalar whereas weight is a vector.

10. Density is mass per unit volume of a substance.

11. Inertia is the property of mass which resists change from its state of rest or motion.

Unit 5 Turning effects of forces

12. **Moment** of a force is the product of a force and the perpendicular distance from the line of action of force to the pivot.
13. **Principle of moments states that when an object is in equilibrium,**
    i. the sum of anticlockwise moment is equal to the sum of clockwise moment about the same point.
    ii. the sum of forces acting on the body is zero.
14. **Centre of gravity** is defined as the point which the entire weight of an object appears to act in any orientation.
15. An object is more stable when :
    i. its c.g. is lowered
    ii. it has a wider base area.
16. Equilibrium means Balance
17. Stable equilibrium – A body returns to its original position after displaced slightly
18. Unstable equilibrium – A body moves away from its original position after displaced slightly.
19. Neutral equilibrium – A body remains where it is displaced when displaced.

Unit 6 Energy, Work and Power

20. Energy is the capacity to do work.
21. **Work done** is the product of force and distance moved in the direction of the force.
22. Gravitational Potential energy is the energy a body has due to its height.
23. Kinetic Potential Energy is the energy a body has due to its movement.
24. **Principle of conversation of energy states:**

    Energy cannot be destroyed or created; it can only be converted from one form to another.
25. **Power** is the rate of work done or work done per unit time.

Unit 7 Kinetic model of matter

26. Kinetic theory of matter states that:

All matter is made up of a large number of atoms or molecules that are constantly moving randomly.

Their speed depends on the amount of kinetic energy they have.

27. Under high temperature, heat energy is converted to the kinetic energy of the particles. Hence, molecules move at greater speed and changes directions more frequently.

Unit 8 Transfer of thermal energy

28. Conduction is the transfer of heat energy from one molecule to the neighbouring molecule by vibration.

i. Air/ Plastic/ Wood are poor conductor/ good insulators of heat.
ii. Metals are good conductors of heat as they have moving electrons to transfer heat energy to nearby and further molecules.

29. Convection is the transfer of heat energy by the movement of liquid or gas.

i. In convection, the liquid becomes hot and expands.
ii. Hot water/air rises as its density becomes lesser.
iii. Cold water/air sinks as it has a higher density.
iv. The replacement of the hot water/air by the cold water/air creates convection current in the liquid.
v. This heats up the whole medium.

30. Radiation is the transfer of heat energy in the form of electromagnetic waves.

i. Black and dull surfaces are good absorbers **or** emitters of radiant heat.
ii. Shiny and white surfaces are poor absorbers **or** emitters of radiant heat.

Unit 9 Thermal Properties of Matter

31. Melting:

Heat is absorbed to break the intermolecular bonds; hence temperature remains constant at melting point.

32. Solidification :

As liquid cools and becomes solid, heat is released and this replaces the heat loss. Hence, temperature remains constant at solidification point.

33. Boiling:

Heat is absorbed to move the molecules apart to form gaseous state; hence temperature remains constant at boiling point.

34. Condensation:

As gas cools to become liquid, heat is released and this replaces heat loss. Hence, temperature remains constant at condensation point.

35. Cooling effect of evaporation:

i. During evaporation, the faster molecules with higher energy leave the surface.
ii. If more molecules leave than molecules entering the liquid, evaporation takes place.
iii. As molecules with higher energy leaves, those with lesser energy are left.
iv. Hence, temperature drops in the liquid.

36. Differences between boiling and evaporation.

i. Boiling takes place at a fixed temperature while evaporation at any temperature.
ii. Bubbles are seen during boiling but not in evaporation.
iii. Boiling takes place throughout the liquid but for evaporation, it is only at the surface.

Unit 10 Light -- Reflection

37. Law of reflection states:

i. The incident ray, reflected ray and the normal at the point of incidence all lies on the same plane.
ii. angle of incidence is equal to the angle of reflection.

38. Properties of image formed by plane mirror is V.U.L.D.S.

(Virtual, Upright, Laterally inverted, Distance equal from the mirror, and Same size)

39. Virtual image is an image which cannot be projected or produced on a screen.

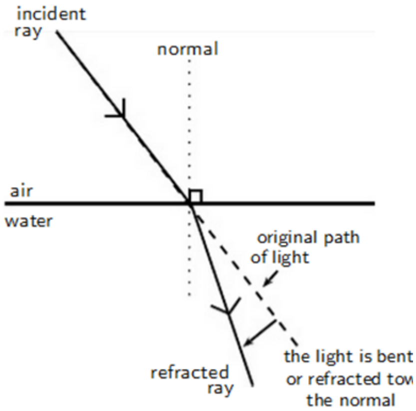
Unit 10 Light -- Refraction

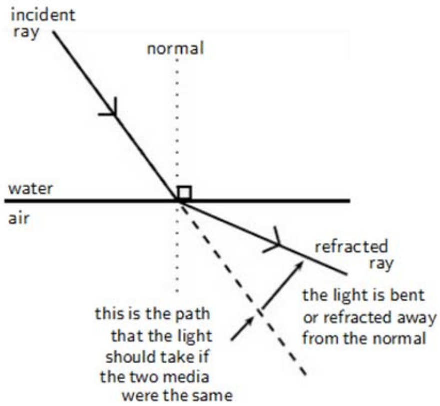
40. Law of refraction states:

i. The incident ray, refracted ray and the normal at the point of incidence all lies on the same plane.

ii. The ratio sin i / sin r is a constant when light passes through.

41. Light bends **away** from normal when it travels from optically dense to less dense medium ; light bends **towards** normal when it travels from optically less dense to dense medium.

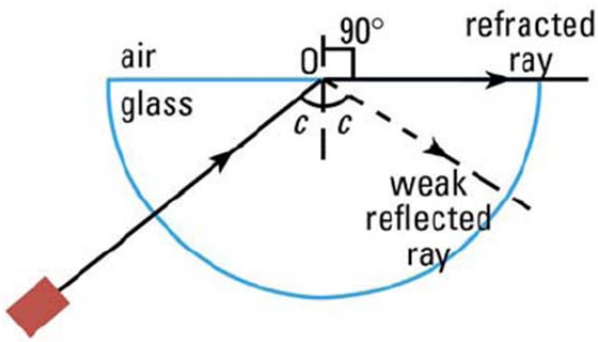




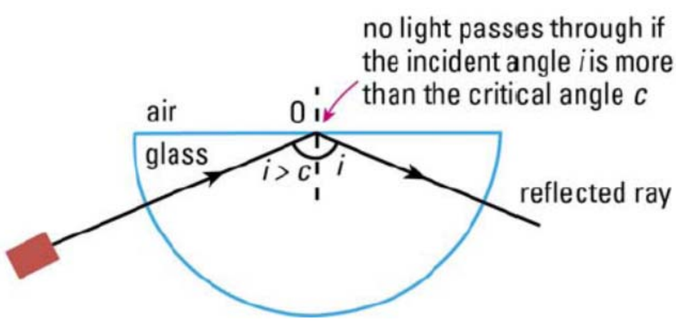
42. **Refractive index** is the ratio of the speed of light in air/vacuum to the speed of light in a medium.

Unit 10 Light – Total Internal reflection

43. **Critical angle** is defined as the angle of incidence when light travels from a denser to a less dense optical medium where angle of refraction is 90^o.



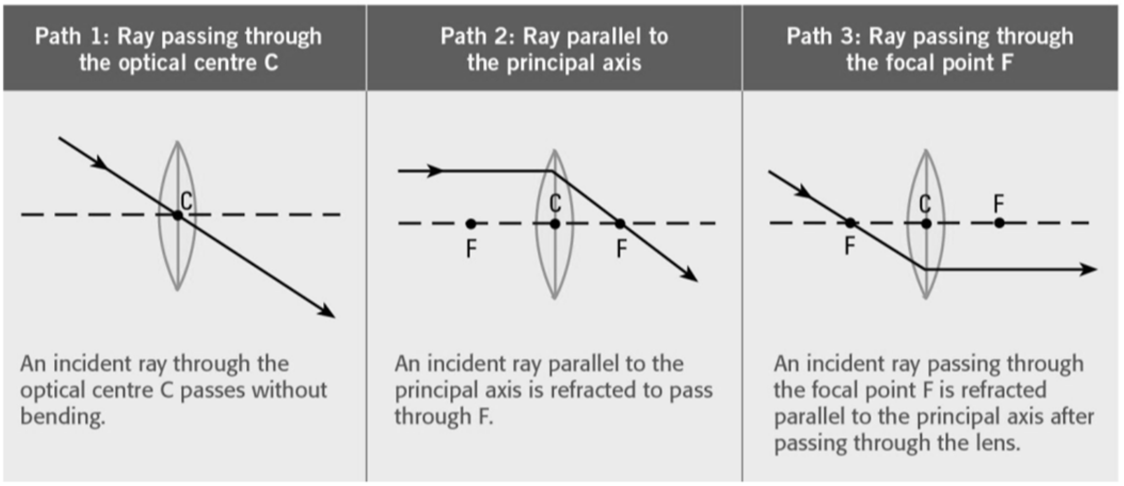
44. Total Internal reflection occurs when the angle of incidence is greater than the critical angel and light is travelling from a denser to a less dense optical medium.



Unit 10 Light – Thin Converging lens

45. **Focal Point** / Principal focus– Point which parallel beams of light passing through a converging lens converge.

46. **Focal Length**—Distance between optical centre and principal focus of lens.



When object is placed	Description of image	Application
at a distance less than F	Virtual, upright, magnified	magnifying glass
between F and 2F	Real, inverted, magnified	Projector
at 2F	Real, inverted, same size	Copier
further than 2F	Real, inverted, diminished	Camera,eye

Unit 11 Waves

47. **Transverse waves** are waves which its particles vibrate perpendicular to the direction of wave motion. E.g. water waves

48. **Longitudinal waves** are waves which its particles vibrate parallel to the direction of wave motion. E.g. sound waves

49. Crest—Highest point of a wave

50. Trough – Lowest point of a wave

51. Amplitude—Maximum displacement from its resting position.

52. Wave speed—Distance travelled by wave per unit time.

53. Wavelength – Distance between two successive crests/ troughs

54. Frequency – Number of complete waves produced per unit time.

55. Period – Time take for wave to make one complete wave motion.

56. Wave front – Imaginary line joining all the crests /trough of a wave

Unit 12 Electromagnetic Waves

57. Electromagnetic Waves consists of the following:

---------- ------------→ Highest Frequency

R M I V U X G

Highest wavelength ←-------------

58. Common properties of electromagnetic waves:

i. They have a speed of 3×10^8 m/s
ii. They can travel through vacuum.

59. Visible Light spectrum :

R O Y G B I V

Unit 13 Sound

60. Sound is produced by a series of vibrations of (air/liquid/solid) molecules that comprises of compressions and rarefactions.

61. Compression—where air/liquid/solid particles are close to each other and compressed. Pressure is maximum

62. Rarefaction – Where air/liquid/solid particles are further from each other. Pressure is minimum.

63. loud sound → high amplitude (higher crest) and vice-versa

64. high pitched → higher frequency (more waves seen) and vice-versa

65. Human hearing range : 20 to 20 000 Hz

66. Ultra sound refers to sound in the range greater than 20 000 Hz

Unit 14 Static Electricity

67. Like charges repel while unlike charges attract.

68. Electric field is a region which an electric charge experiences a force.

Unit 15 Current electricity

69. Electric current is the rate of flow of charges.

70. Potential difference between two points is the energy required to move a unit charge between the two points.

71. Electromotive force is the energy used to drive a unit charge around the complete circuit.

72. Ohm's Law states that the current passing through a metallic conductor is directly proportional to its p.d provided all temperature remains constant.

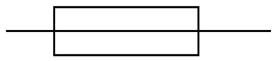
73. An ohmic conductor is one where the p.d./ current graph is

i. a straight line

ii. passes through the origin.

Unit 16 DC circuits NA

Unit 17 Practical electricity

74. A fuse is a safety device that limits the current a circuit can carry. 

75. When the current exceeds the fuse rating, the fuse will blow and stop electric supply to the circuit.

76. Color codes for three pin plug wire:

i. Earth—Yellow and green

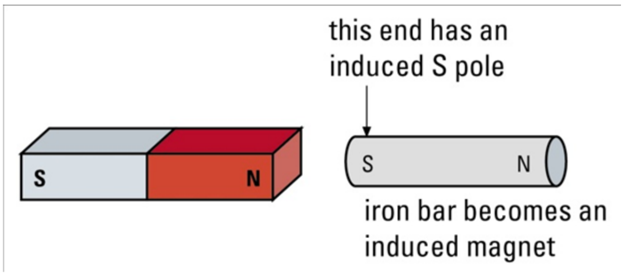
ii. Live – Brown

iii. Neutral-- Blue

77. The earth wire is connected to the metal casing of an appliance so that user will not get an electric shock in case of a fault.

78. Switches and fuses are placed along live wire so that when the fuse/switch break, the user is protected from electrical shock as it isolates the device from the power supply.

79. Magnetic induction occurs when a permanent magnet is brought close to a magnetic material and it becomes a magnet.



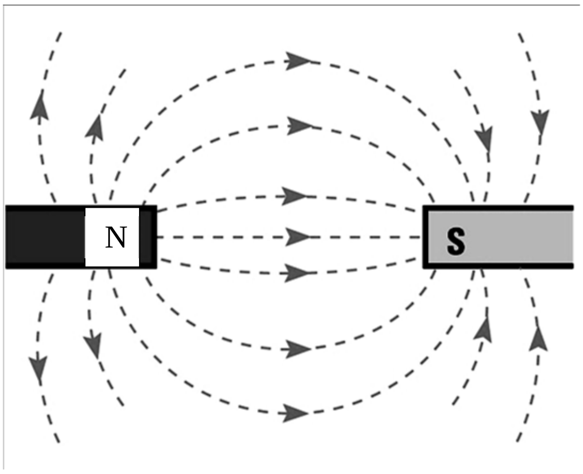
80. Magnetic materials include Iron, Cobalt, Nickel, Steel

81. Non Magnetic materials include Copper, Aluminium, Lead and non metals

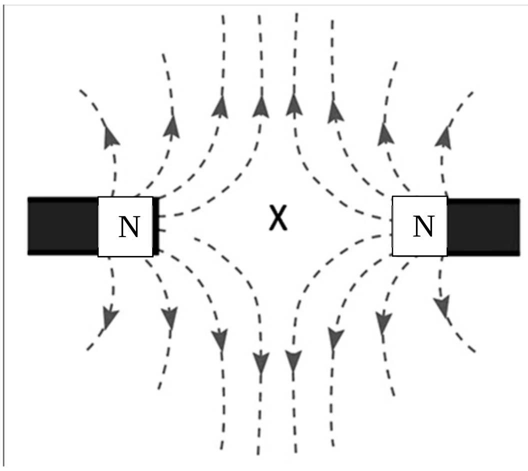
The test for a permanent magnet is **repulsion**.

82. Magnetic field lines:

Unlike poles



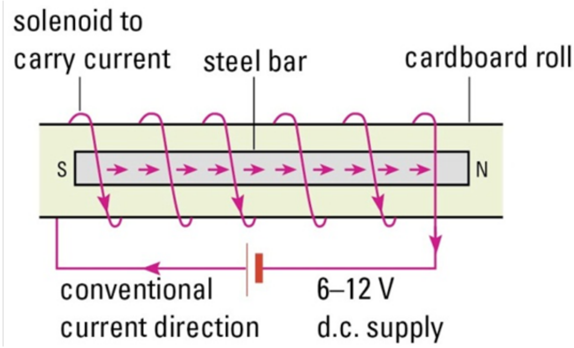
Like poles



83. Iron is a magnetic material that is easily magnetized and demagnetized. It is commonly used as electromagnet. Also known as temporary magnet when magnetized.

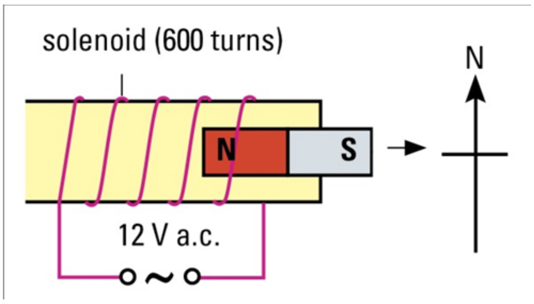
84. Steel is a magnetic material that is hard to magnetised but retains its magnetism well. It is used to make permanent magnets.

85. Best method of magnetization: Using Direct Current with a solenoid

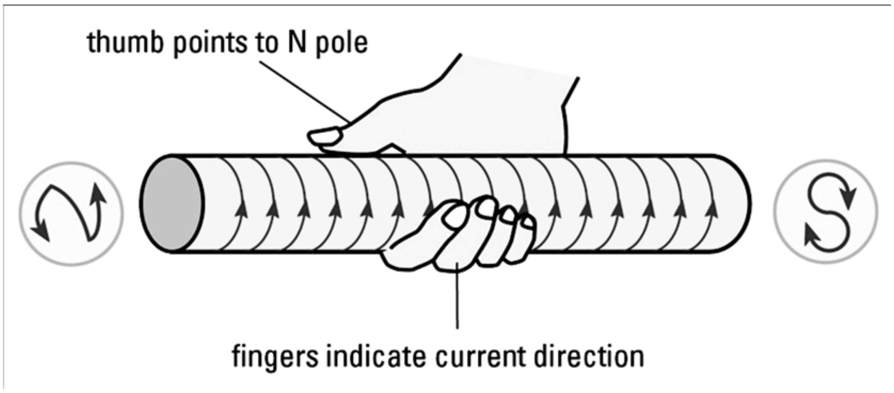


86. Best method of demagnetization:

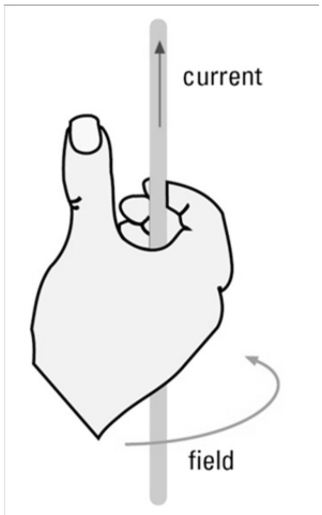
Using Alternating current in a solenoid while pulling the magnet out in east west direction



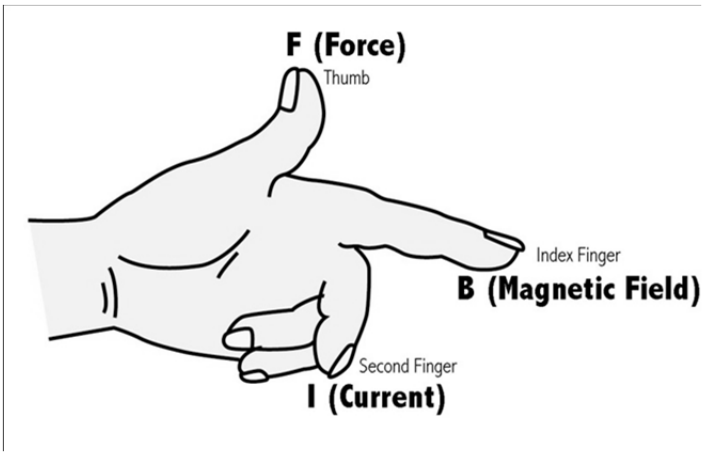
87. To find the magnetic pole (North or South) in a solenoid, use Right Hand grip Rule.



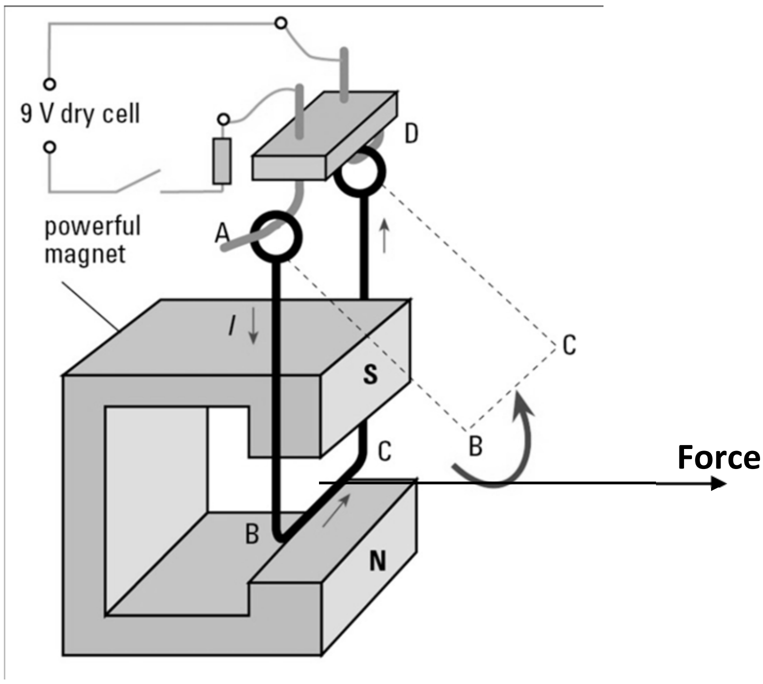
88. To find the direction of magnetic field (Clockwise or anti-clockwise) around a wire carrying current, use Right hand grip rule.



89. To find the force acting on a current carrying wire in a magnetic field, use Fleming's Left Hand Rule.



Example:



4. Practical Exam Guide

I. List of measurement and units

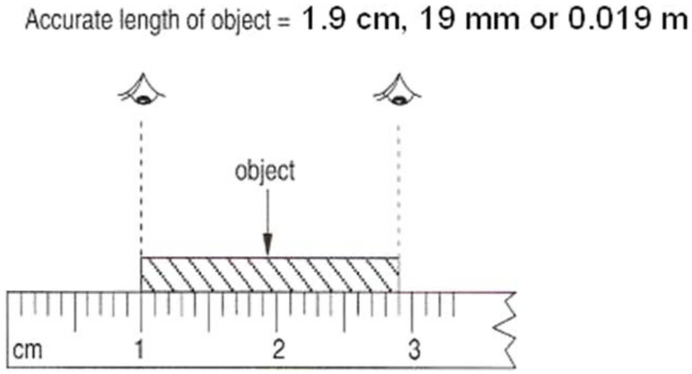
Below are the degrees of uncertainty of some often used measuring instruments:

No	Instrument	Smallest Division	Uncertainty	Sample readings
1.	Protractor	1°	0.5°	5.0°, 11.5°, 24.5°
2.	Metre rule	0.1 cm	0.1 cm	25.0 cm, 25.1 cm. 25.2 cm
3.	Micrometer	0.01mm	0.01mm	5.00mm, 5.09mm, 5.11mm
4.	Sliding mass balance	0.01g	0.01g	1.00g, 5.99g. 9.17g
5.	Electronic mass balance	0.01g	0.01g	1.05g, 6.09g, 10.22g
6.	Stopwatch(digital)	0.01s	0.01s	28.00s, 28.10s, 28.17s
7.	Measuring cylinder(100ml)	1ml	0.5ml	80.0 ml, 85.5 ml, 92.0 ml
8.	Measuring cylinder(250ml)	2ml	1ml	50ml, 51ml,55ml
9.	Thermometer (-10 °C to 110 °C)	1 °C	0.5°C	12.5°C, 14.0°C, 15.5°C
10.	Spring balance (0-1 N)	0.01 N	0.01N	0.37N, 0.45N, 0.78N
11.	Spring balance (0-10 N)	0.1 N	0.1N	4.5N, 4.6N, 4.7N
12.	Ammeter (0-1 A)	0.02 A	0.01A	0.30A,0.31A, 0.32A
13.	Ammeter (0-3 A)	0.1 A	0.05 A	1.20 A, 1.25A, 1.50 A
14.	Voltmeter (0 – 1 V)	0.02 V	0.01V	0.50 V, 0.51 V, 0.52 V
15.	Voltmeter (0 – 3 V)	0.1 V	0.05V	2.50V, 2.55V, 2.60V

II. Reading and recording

Some of the commonly used instruments are discussed below:

- **Metre rule**



Read to the smallest division.

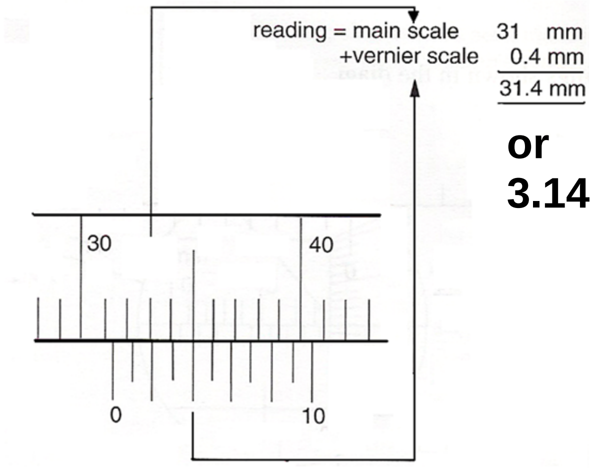
Take note of the decimal place (d.p.)

cm: 1 dp (1.9 cm)

mm: whole number (19mm)

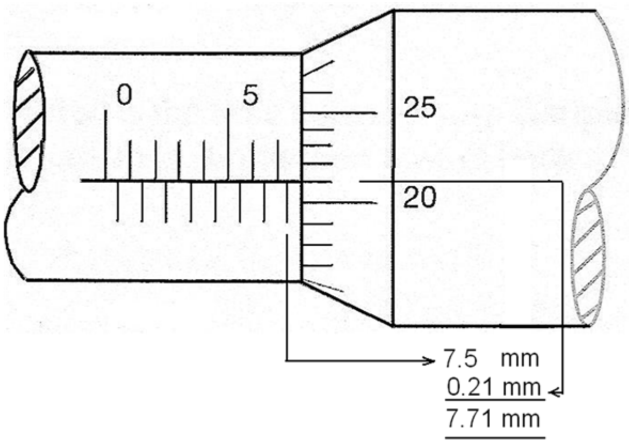
m : 3 dp (0.019 m)

- **Vernier Calipers** – Read up to 2 d.p. (in cm) or 1 d.p (in mm)



or
3.14 cm

- **Micrometer --** Read up to 2 d.p. (in mm)



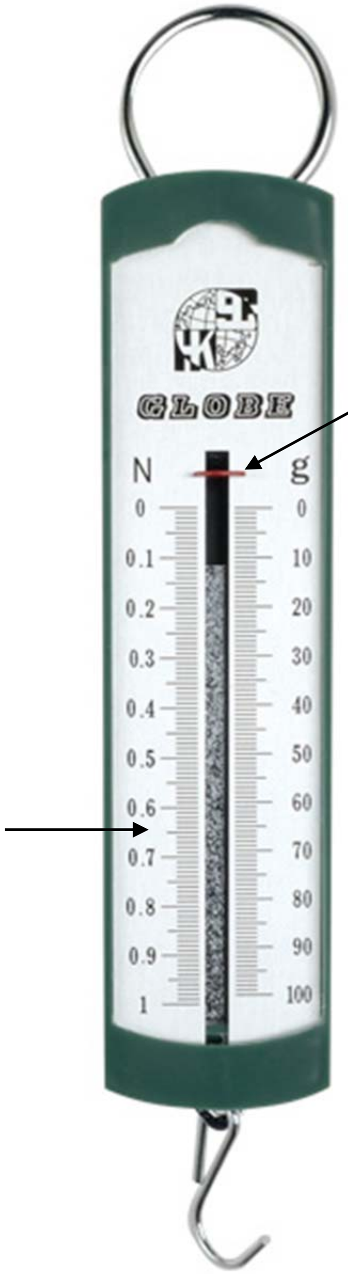
- **Stop Watch** -- Read up to 2 d.p. (in s)

Example: <u>11.32 s</u>

- **Electronic mass balance –** Read up to 1 d.p.

Example: <u>142.5 g</u>

- **Spring Balance (up to 1N or 100g)** -- Read up to 0.01 N or 1 g

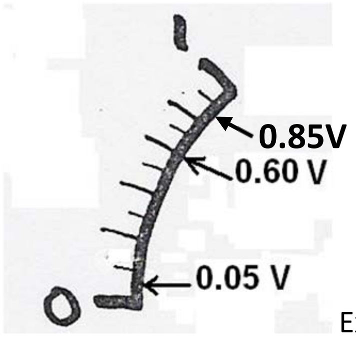


Note:
This spring balance need to be adjusted if the red pointer is not in line with zero.

Example (with reference to **arrow**): <u>0.65 N or 65 g</u>

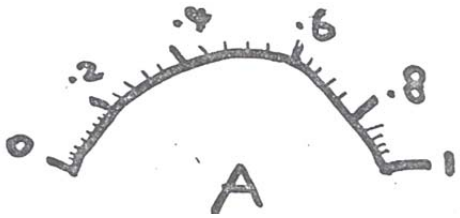
- **Voltmeter & Ammeter --** Read up to **half** the smallest division for both.

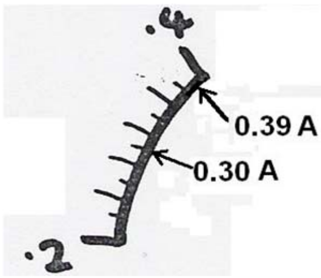
Voltmeter (0-3 V)



Example : <u>0.60 V or 0.05 V or 0.85V</u>
<u>(accurate to 0.05 V)</u>

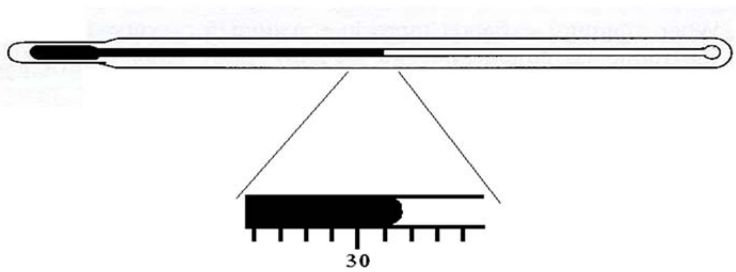
Ammeter (0-1 A)





Example : <u>0.30 A or 0.39 A</u>
<u>(accurate to 0.01 A)</u>

- **Thermometers (Laboratory)--** Read to half the smallest division. i.e. last digit : 0.0°C or 0.5 °C



Example: **<u>31.5 °C</u>**

III. Conversion of units

Examples:

(a) 1 m = 100 cm

(b) 1.0 cm = 0.01 m

(c) 1 kg= 1000 g

(d) 1g = 0.001 kg

(e) 1 m^3 = 1000 cm^3

(f) 1 cm^3 = 0.001 m^3

(g) 1 min = 60 secs

IV. Handling numbers

(a) For experiment data, **numbers should be rounded off to the same decimal place as the data collected**.
E.g. Finding average of 20.50s and 21.52 s should be written as 21.01s

(b) For calculations such as finding T^2, round off to **3 s.f. unless stated otherwise**.
E.g. Finding T^2 where T = 2.01s will give you 4.04 s.

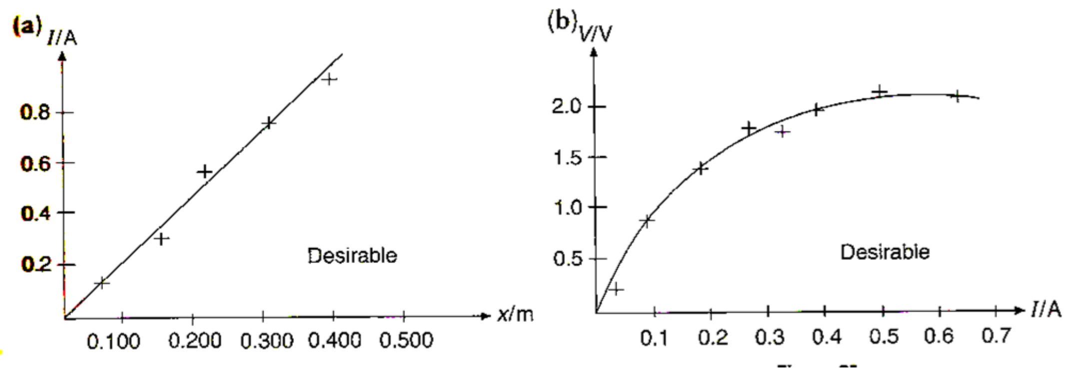
V. Displaying data on graphs

The following points are noted when drawing graphs:

- **A**xes:
  --Both axes should be labeled.
  When asked to plot A against B,
  A refers to the Y axes (or the vertical axes);
  B refers to the X axes (or the horizontal axes).

- **S**cale:
  --Select an appropriate scale.
  eg. 1 sq to 2 units , Other acceptable scale 1 sq to 1, 5, 10, 20 or 50 units.
  Avoid 1sq to 3 units or 7 units
  --Use a convenient scale to draw the graph as large as the available space.
  Scale should allow the length of first to last data point to occupy more than half of graph paper in both directions. At least 6 sq.s for vert., 5 sq.s for horizontal.

- **P**oints must be clearly and accurately marked. Do this with a cross! (X).
- **L**ine--Use a 2B pencil to draw the straight line or curve.
  For a straight or curve line, draw the **best fit line.(equal distribution of points).**



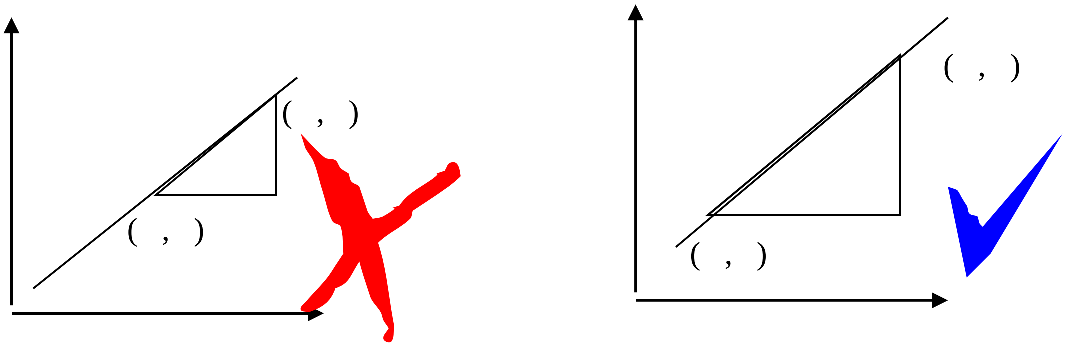
- Calculating gradient:

  -- Mark out two widely separate points on the graph
  Label the coordinates of the two points

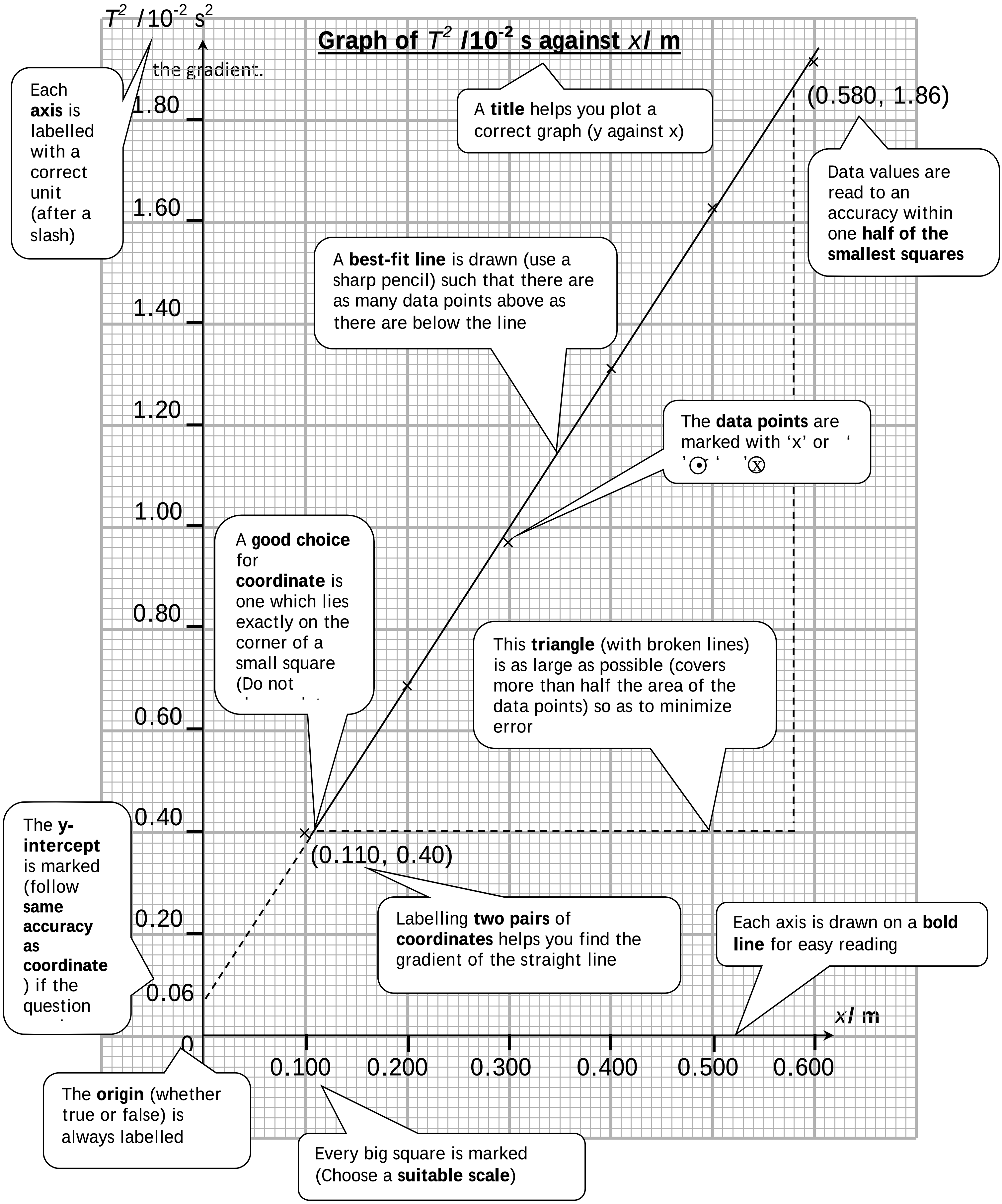
  Use $g = \frac{y_1 - y_2}{x_1 - x_2}$ to find the gradient.

  -- **Show your workings of gradient on graph or on answer sheet!!!**

  -- Note that Gradient triangle's hypotenuse must be longer than half length graph.

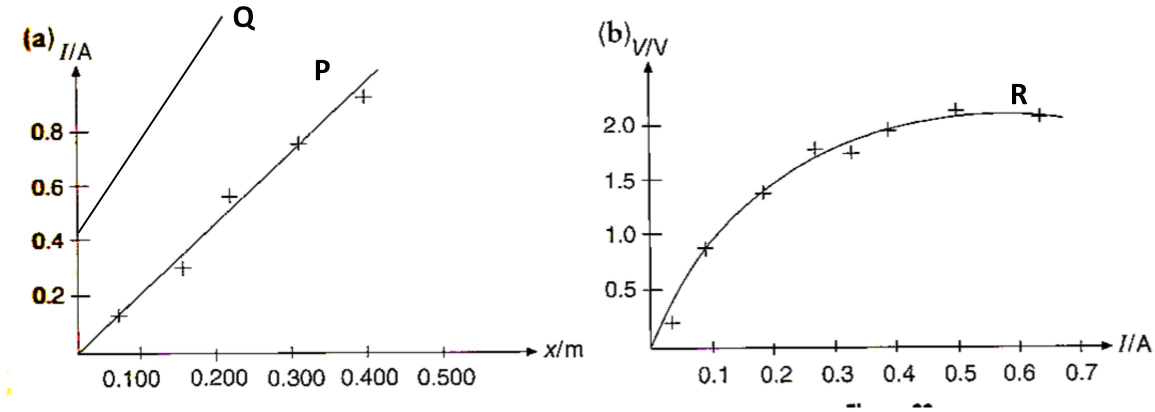


Example of a good graph



VI . Describing relationships, sources of errors and improvements.

- Relationships between variables:



<u>**P**: I is directly proportional to x. (if it passes through origin)</u>

<u>**Q**: I is linearly related to x (if it does not pass through origin)</u>

<u>**R**: V increases in lesser amount compared to the increases in I (non linear)</u>

- **Sources of error:** refers to instruments inaccuracy or set-up conditions that lead to errors of readings. It is also difficult to correct these errors in an experiment and have to be accounted in the answers.

A. *General Physics*

Time related e.g. Pendulum—Human reaction time leads to inaccurate reading of the timings taken when the period of oscillation is calculated.

Retort stands—When restort stand is used, the height of the metre rule is difficult to achieve accurately as required as it is difficult to make small adjustments to the clamp.

B. *Light*

Optical pins—The size of the pin holes affect the accuracy of the emergent or incident lines constructed and hence affect the readings taken.

Glass block--The rectangular glass block, with the beveled edges, makes it hard to replace it on the exact position each time. This leads to inaccurate readings taken.

The pins cannot be placed exactly at the glass block due to the thickness of the pin hence there may be inaccurate construction.

Mirror—the mirror is light and shifts easily despite checks. This causes error in the angle of incidence and hence the rays drawn.

C. *Electricity*

Resistance wire--Kinks in the wire cannot be straightened out on the ruler and hence lead to inaccurate measurement

--The wires are not of uniform thickness hence the overall resistance will be affected.

--Contact of the jockey is not consistent thus causing some variations in the reading of current and voltage.

- **Precautions**

    A. *General Physics*
    Check for zero errors in the instrument (e.g. vernier calipers, micrometer and Newton metre/spring balance)
    Avoid parallax error in reading a scale by placing the eye vertically above the mark on the scale.

    B. *Light*
    Ensure the pins are upright and aligned.
    Make sure the pins are at least 5 cm apart.
    The holes made by the optical pins on the paper should not be too big.
    The lens, screen and object must be placed along the principal axis of the lens and their planes perpendicular to the principal axis.

    C. *Electricity*
    A circuit must be discounted if no reading is taken. This is to prevent overheating of the wire and cause the resistance to change. (or increase)
    Check for zero error in the ammeter and voltmeter.

O level practicals summary

YEAR	TOPIC TESTED	MARKERS' reports and Highlights
2002	Electricity	Sources of error: Kinks in the wire cannot be straightened out on the ruler and hence lead to inaccurate measurement The wires are not of uniform thickness hence the overall resistance will be affected. Contact of the jockey is not consistent thus causing some variations in the reading of current and voltage.
2004	Moments (paper clip)	Note: Angle measurement to either 1 d.p or none. E.g. 40^o , 40.5^o
2005	Determine **g** by rolling a cylinder down a ramp	Note: Time measured to 2 d.p., e.g. 23.55s ; indicate calculation of gradient on the graph!! Sources of errors 1) Human reaction time errors during the timing of the start and stop portion. 2) Surface texture results in friction between plank and rod 3) Timing taken three times Improvements 1) Use a photogate or motion sensor to record start and stop times as the rod is released 2) Use a material such as glass,plastic, metal 3) Increase no. of repetitions of timing from 3 to 5 Explanation 1) This is used because the error occurred in the timing is minimized and more consistently small. 2) To reduce friction in consistencies of surface material. 3) By increasing more repetitions and averaging out, it can increase the accuracy of data and minimise the errors.
2006	Determine **g** by using a pendulum	Sources of error: see pg 28 on errors for pendulum Improvements: 1) Using lengths beyond 70 cm; 2) Repeating the experiments so that an average could be calculated 3) Increasing the number of periods timed
2007	Light (glass block)	Improvements: 1) Using thinner pins so that the size of hole made is smaller and hence allows a more accurate construction of line. 2) Use more pins to construct a more accurate line of the path of light. 3) Repeat the experiment by using other angles of incidence to collect more data for plotting the curve. (eight would be good)